C. V. Raman Global University
ODISHA BHUBANESWAR INDIA

Major project report on

IoT Based Smart Energy Meter

(7th Semester ECE Branch)

Submitted By Group 11

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CERTIFICATE FROM SUPERVISOR

This is to certify that the Experiential Learning Project report entitled "IoT based smart Energy Meter" submitted in partial fulfilment of the requirement for the award of Bachelor of Technology in ECE of the C. V. Raman Global University, Odisha during the year 2022-2023, is a faithful record of the bonafide work carried out by Biswabandita Sahoo(20010664), Abhishek Abhinav(20010665), Jiban Jyoti Biswal(20010666), Jyotir Aditya Mishra(20010668), Aman Kumar Nayak(20010682) under my guidance and supervision.

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ABSTRACT

IoT has transformed our interaction with the physical world, with significant implications for the energy management sector. This abstract explores the vital role of Arduino Uno, a versatile microcontroller board, in facilitating energy monitoring systems. By seamlessly integrating sensors and programming, Arduino Uno enables the measurement and analysis of electrical parameters, providing valuable insights for effective energy consumption analysis. In densely populated nations, where tracking electricity theft, consumption and real time energy monitoring poses challenges, this project seeks to address these issues, offering a solution to enhance energy management and security with the help of both software (proteus) and Hardware model.

INTRODUCTION

The Internet of Things (IoT) marks a transformative era in reshaping our interaction with the physical world. Among its impactful applications, IoT plays a pivotal role in revolutionizing the energy management sector. Arduino Uno, a microcontroller board, stands at the forefront of this evolution, enabling seamless integration with various sensors for effective energy consumption analysis. Particularly crucial in densely populated nations facing challenges in tracking electricity theft, this project aims to leverage IoT and Arduino Uno to enhance energy management, security, and efficiency, promising a future where intelligent connectivity and data-driven insights redefine global energy practices.

Arduino Uno, is designed for diverse electronics projects, offering unparalleled ease of programming, robust connectivity options, and broad compatibility with an extensive array of sensors. Its versatility makes it an ideal choice for both beginners and experienced enthusiasts, facilitating seamless integration into various applications. With an intuitive programming interface, it empowers users to bring their electronic ideas to life effortlessly. Whether interfacing with sensors, actuators, or other components, the board's adaptability and user-friendly features make it a cornerstone for innovation, fostering a vibrant ecosystem of creative electronics projects.

The synergy enables the board to measure and analyze crucial electrical parameters, laying the foundation for effective energy consumption analysis. By interfacing with sensors, Arduino Uno transforms into a dynamic hub that captures real-time data, allowing users to gain comprehensive insights into their energy usage patterns. This functionality not only facilitates informed decision-making but also empowers individuals and industries to optimize energy efficiency, contributing to a more sustainable and conscientious approach to resource consumption in the ever-evolving landscape of electronic applications.

In densely populated nations, the complexities of managing electricity theft and consumption are exacerbated by inherent tracking challenges. The proposed project represents a targeted initiative to effectively tackle these issues. By leveraging innovative solutions and technologies, it seeks to establish a comprehensive system capable of not only tracking but also mitigating electricity theft. The project's focus on addressing the unique challenges in densely populated areas demonstrates a commitment to enhancing energy security .

METHODOLOGY

Circuit Diagram :-

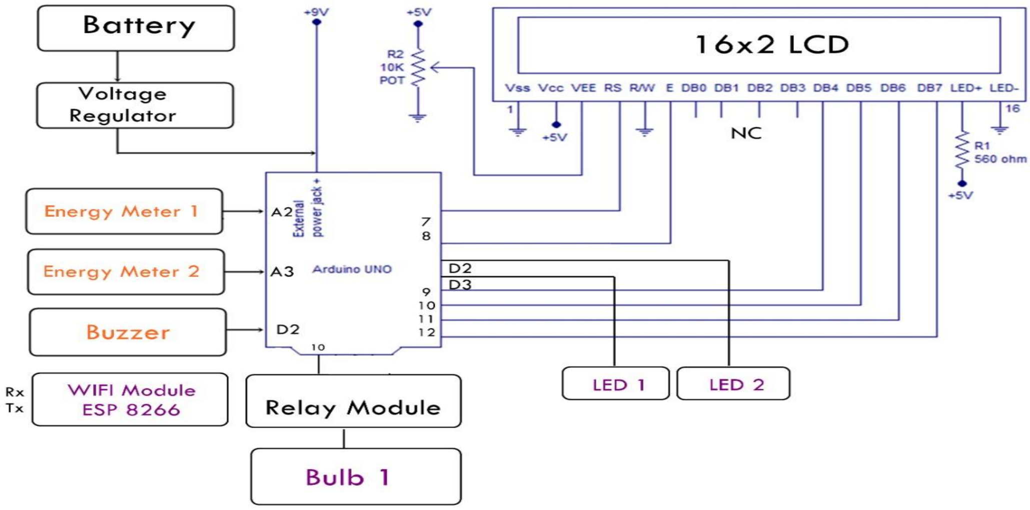

Figure No. 1 - Circuit Diagram

Hardware Components & Software Used:-

<u>Arduino UNO</u> :-
Arduino Uno is a microcontroller board widely employed in energy metering applications. Its ease of programming and compatibility with various sensors make it a preferred choice for developing energy monitoring systems.

Figure No. 2 - ARDUINO UNO

When integrated into energy meters, Arduino Uno enables the measurement and analysis of electrical parameters, facilitating real-time monitoring of energy consumption. Arduino Uno's connectivity options make it a reliable component in creating smart energy metering solutions, contributing to advancements in monitoring, analysis, and control within the energy management.

Energy Meter :-
An energy meter is a device used for measuring and quantifying electrical consumption in a given system. It plays a important role in tracking the amount of electricity consumed by a household, commercial building, or an industrial facility. Energy meters provide accurate data on power consumption, in billing processes and enabling users to monitor and manage their energy usage effectively. Modern energy meters often incorporate advanced features such as real-time monitoring, communication capabilities, and integration with IoT technologies. These enhancements contribute to more efficient energy management.

Electromagnetic Relay Module :-
The Electromagnetic Relay Module is a critical component used in energy meters to control electrical circuits. It serves as a switch that can be activated by an electrical signal, allowing it to open or close the circuit based on specific conditions. In an energy meter , the relay module is often utilized for tasks such as disconnecting or reconnecting the power supply based on user authorization or billing status.

Figure No. 3 - Relay Module

This functionality is essential for implementing measures like disconnecting power in case of non-payment or during maintenance. It enhances the automation and control capabilities of energy meters, contributing to efficient energy management and ensuring secure and reliable operations.

Female to Female Jumper wire :-
These wires feature connectors at both ends with female pins, allowing them to establish connections between various electronic components. In the context of

energy meters, these jumper wires are instrumental in linking different modules, such as microcontrollers, sensors, and display units. The female-to-female jumper wires contribute to the overall reliability and functionality of energy meters by ensuring secure and stable connections, making them a crucial element in the construction and maintenance of these monitoring devices.

PIR Sensor :-

A Passive Infrared (PIR) sensor is a key component in energy meters, particularly for applications involving occupancy detection and energy conservation. PIR sensors detect changes in infrared radiation within their field of view, typically caused by the movement of people or objects. In an energy meter context, PIR sensors are employed to determine occupancy within a space. By detecting human presence or movement, these sensors can trigger actions such as activating or deactivating certain functions in the energy meter, optimizing energy consumption based on real-time occupancy data.

LDR :-

A Light Dependent Resistor (LDR) is a valuable component in energy meters, contributing to their functionality in light sensing and control applications. LDRs are semiconductor devices that exhibit a change in resistance based on the intensity of light falling on them. In energy meters, LDRs are often utilized to gauge the ambient light conditions surrounding the metering equipment. This information can be crucial for triggering specific actions, such as adjusting the brightness of display units or controlling the activation of certain features based on the external lighting conditions.

Other components are Resistance-1km ohm, Capacitor 100uF, Diode 1N4007 ,LCD , LED, Zero PCB and ARDUINO IDE 1.8.14 .

This whole procedure based on the Arduino. This project is focused on the connectivity and networking factor of the loT. In this system, an energy consumption calculation depend on the calibration counting pulses is designed by using ARDUINO UNO Microcontroller in embedded system domain.

The meter reading procedure is automatic by linking the electricity energy meter with ESP 8266Es Wi-Fi module and LDR and PIR sensor. LDR sensor has the purpose of measuring the electric current units.Wi-Fi box provides IP address to electricity energy meter. To identity the electricity theft attempt via tampering we use 2 way theft detection one via meter temparing and 2nd one via theft overload .

According to the data received, the microcontroller will send the notification regarding tampering information to the server side (Thinkspeak).

ARDUINO CODE (For Hardware Model)

```
#include<LiquidCrystal.h>
LiquidCrystal lcd(7,8,9,10,11,12);
#include <SoftwareSerial.h>
long  t2=0, t3=0, t4=0;
SoftwareSerial ser(5, 6); // RX, TX
String stri, strj, strk;
int theft=0;
char buf1[16];
char buf2[16];
char buf3[16];
// replace with your channel's thingspeak API key
String apiKey = "ZMRIIM142D84QD0H";
int timesTosend=1;
int count2=0;
int count3=0;
int i=0;
int sem=0;
int count =0;
int count1 =0;
int bill = 50;
long measurementStartTime = 0;
int sensepin = A4; //energy meter

void setup(){
  Serial.begin(9600);
  lcd.begin(16,2);

     ser.begin(115200);
// reset ESP8266
  ser.println("AT+RST");
   delay(500);
  ser.println("AT+CWMODE=3");
   delay(500);
  ser.println("AT+CWJAP=\"project\",\"12345678\"");
  delay(500);

  lcd.setCursor(0,0);
      lcd.print("Energy Meter");
```

```
      lcd.setCursor(0,1);
      lcd.print("Count:");

      analogReference(DEFAULT);
      pinMode(A3, OUTPUT);
      digitalWrite(A3, HIGH); //relay
      pinMode(A5, OUTPUT);
      digitalWrite(A5, LOW); //buzzer
}

void loop(){
 // Serial.println(analogRead(A0));
 if(analogRead(A0)>500)
 {
   digitalWrite(A3, LOW);
 }
 else
 {
   digitalWrite(A3, HIGH);
 }
  if((analogRead(A4) > 500) && (sem == 0))
{
  sem = 1;
count1=count1+10;
  count=count+10;;
  Serial.println(count1);
}
lcd.setCursor(8,1);
      lcd.print(count);
if((analogRead(A4) <= 500) && (sem == 1))
{
  sem = 0;

}
//if(i==0)
//{
//Serial.println("Recharge Now");
//
//   digitalWrite(A3, HIGH); //relay
//
//}
//if(i>0)
```

```
//{
//   digitalWrite(A3, LOW); //relay
//}
//if(count==5 && i >0)
if(count==50)
{

           // count = 0;
 }
stri = dtostrf(count, 4, 1, buf1);

   // Serial.print(stri);
//  Serial.println(" ");


     if(millis() - t2>15000)
  {
    t2=millis();

   // TCP connection
  String cmd1 = "AT+CIPSTART=\"TCP\",\"";
  cmd1 += "184.106.153.149"; // api.thingspeak.com
  cmd1 += "\",80";
  ser.println(cmd1);

  if(ser.find("Error")){
    //Serial.println("AT+CIPSTART error");
    return;
  }

 // prepare GET string
  String getStr1 = "GET /update?api_key=";
  getStr1 += apiKey;
  getStr1 +="&field1=";
  getStr1 += String(stri);
  getStr1 += "\r\n\r\n";

// send data length
  cmd1 = "AT+CIPSEND=";
  cmd1 += String(getStr1.length());
  ser.println(cmd1);
```

```
    if(ser.find(">")){
     ser.print(getStr1);
   }
    else{
     ser.println("AT+CIPCLOSE");
     // alert user
     Serial.println("AT+CIPCLOSE");
   }
   }
  if (millis() - measurementStartTime >= 10000)  //time is
up
   {
       Serial.println("10secs");
     measurementStartTime = millis();
     if(count1 > 50)
     {
      lcd.setCursor(0,0);
       lcd.print("Theft      ");
    Serial.println("Theft detected");
     digitalWrite(A5, HIGH); //buzzer
    delay(1000);
    digitalWrite(A5, LOW);
      count2=0;

     }
     if(count1 == 40)
     {
       lcd.setCursor(0,0);
       lcd.print("Overload      ");
    Serial.println("Overload detected");
     digitalWrite(A5, HIGH); //buzzer
    delay(1000);
    digitalWrite(A5, LOW);
      count2=0;

     }
     count1=0;
   }

}
```

SIMULATION

Proteus (Software) Simulation :-

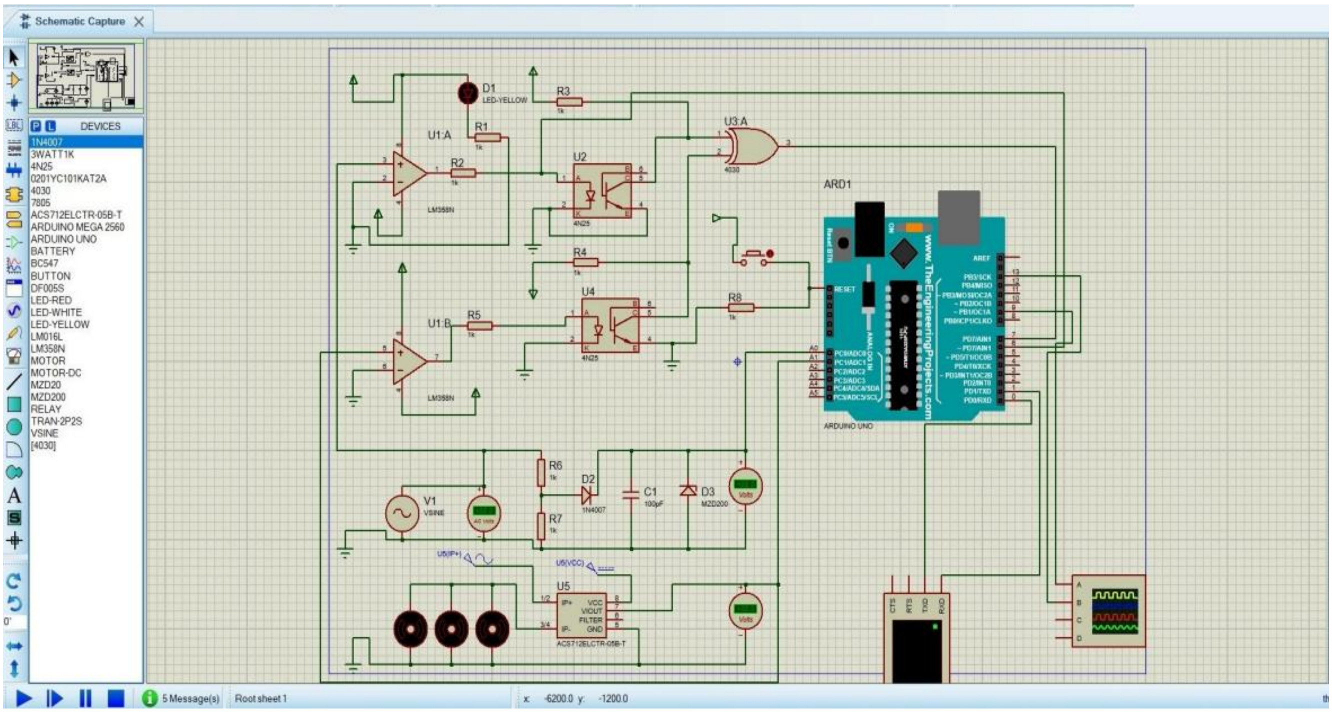

Figure No. 4 - Proteus Model

Hardware Model :-

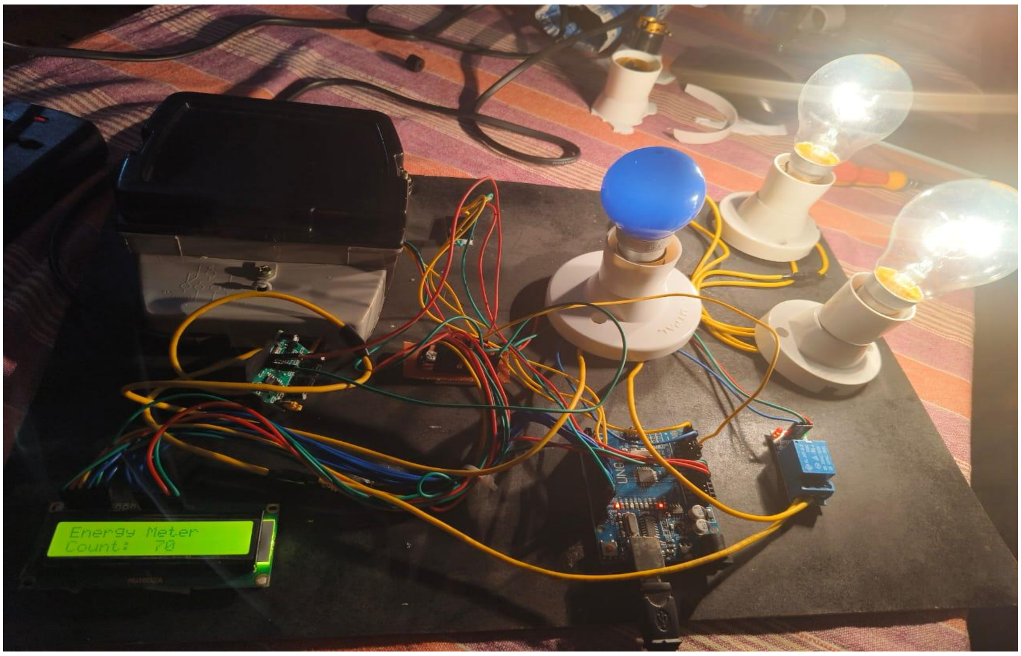

Figure No. 5 - Hardware Model

RESULTS

Proteus Model:-

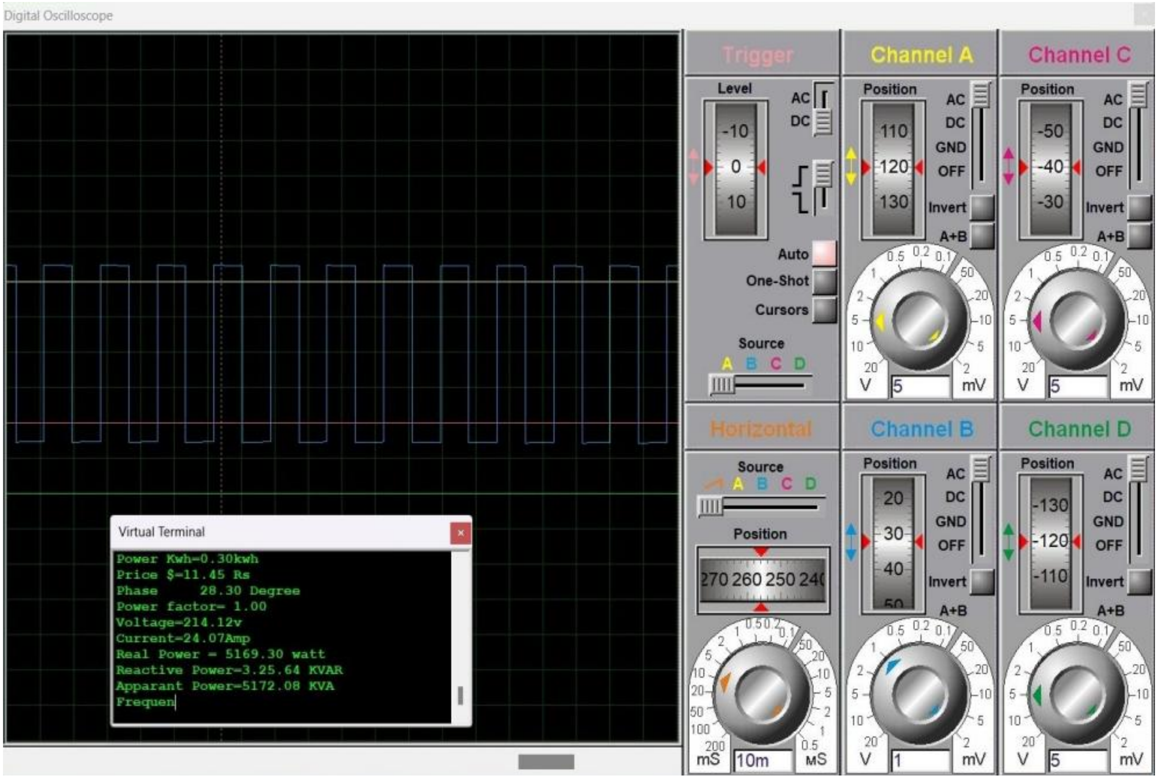

Figure No. 6 - Proteus Model Result

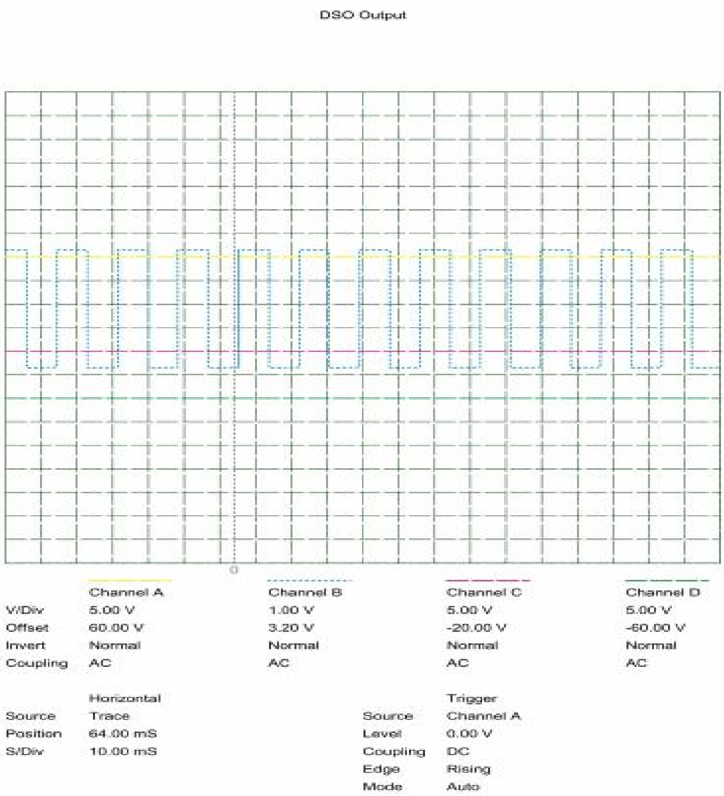

Figure No. 7 - Proteus Model Result (DSO Output)

Hardware Model :-

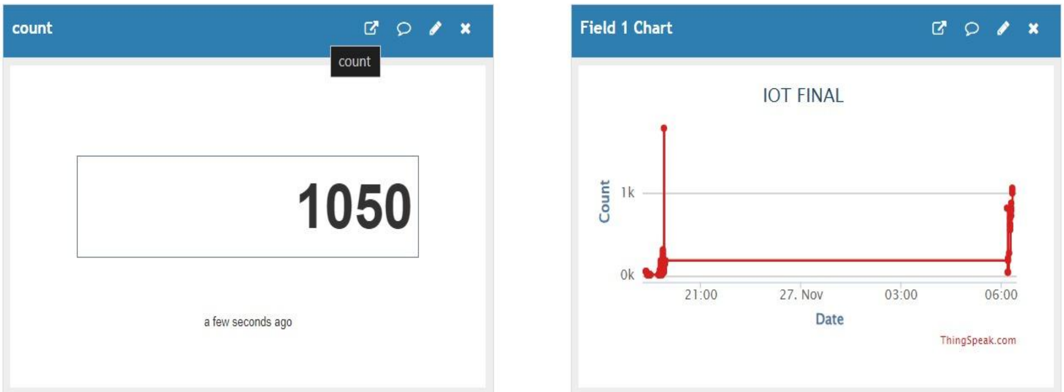

Figure No. 8 - LED Bulb Result (Thinkspeak)

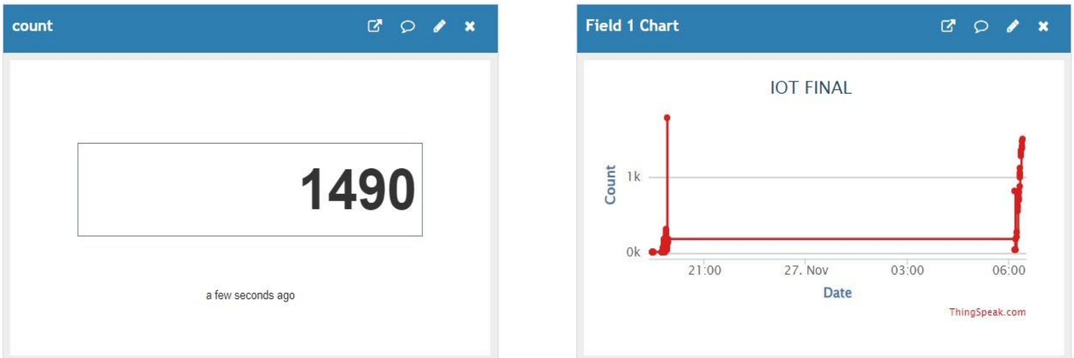

Figure No. 9 - Mix Bulb Result (Thinkspeak)

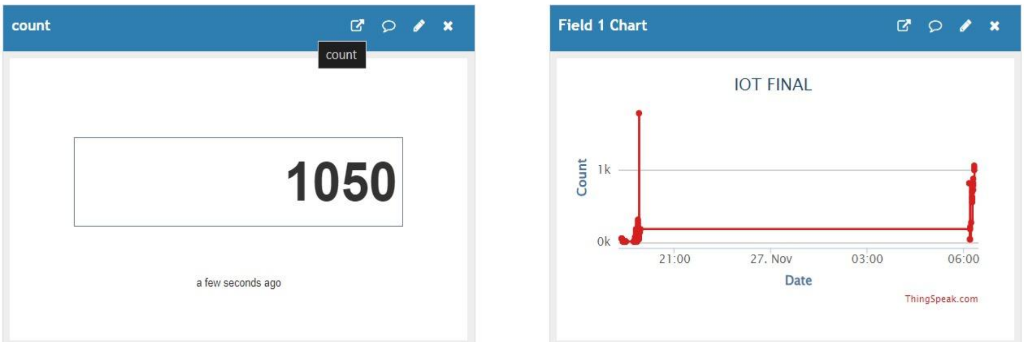

Figure No. 10 - 100W Bulb Result (Thinkspeak)

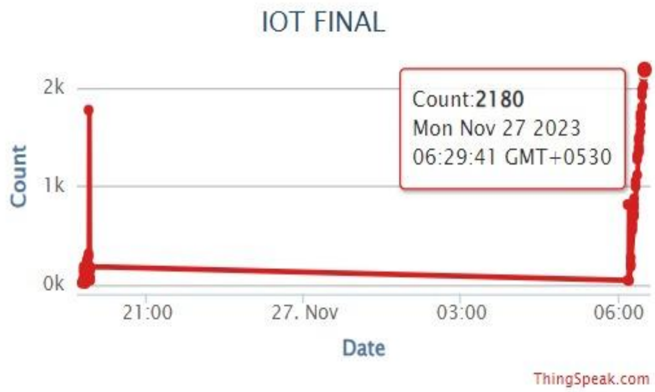

Figure No. 11 - Mix Bulb Threshold Value (Thinkspeak)

CONCLUSION AND FUTURE SCOPE

In conclusion, the implemented system marks a significant advancement in energy management, offering comprehensive features such as real-time monitoring, theft detection, and efficient energy consumption analysis.

In future, the internet of Things (IoT) and smart energy meter reading systems presents a transformative approach. This innovative system continuously monitors meter readings, ensuring a constant and accurate overview of energy consumption patterns. It introduces a mechanism where, if a customer fails to pay the monthly bill, the service provider can remotely disconnect the power source. This forward-thinking capability enhances the efficiency of billing processes, creating a more responsive and secure energy infrastructure. Moreover, the incorporation of IoT technology eliminates human involvement, streamlining operations and reducing the likelihood of errors. With automated meter readings, the system delivers not only accuracy but also timeliness in information retrieval, contributing to more effective energy management practices.

Additionally, the system acts as a safeguard against billing faults. By automating the reading and billing processes, it minimizes the potential for discrepancies, ensuring that customers are accurately billed for their energy consumption. This not only enhances the reliability of the billing system but also trust between consumers and service providers. In essence, the integration of real-time monitoring, theft detection, and IoT-based meter reading not only addresses current energy challenges but also sets the stage for a more efficient, secure, and technologically advanced energy management landscape in the future.

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